MIARGYRITE SILVER ORE FROM THE RANDSBURG DISTRICT, CALIFORNIA

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INTRODUCTION

Miargyrite, one of the rarest of the sulphantimonites of silver crystallizing in the monoclinic system, has the formula $Ag_2S.Sb_2S_3$. It has been found in the United States only in the Flint and Silver City districts in Owyhee County, Idaho,[1] and in the Randsburg district of California.[2] In the latter district it has been abundant in the bonanza silver ores lately worked by the California Rand Mining Co. Shortly after the discovery of the rich silver ores of these mines an excellent series of specimens was obtained for the National Museum by Frank L. Hess. These specimens form the basis for the following description.

Although the Randsburg district has been prospected since the sixties and has been an active mining region since 1893, the rich silver ores were not discovered until April 12, 1919.[3] The original outcrop of the ore was on the Juanite claim, only about 30 feet from a well-traveled road about 2 miles southeast of the town of Randsburg. The ore at the surface was very rich and all of the material mined was shipped to the smelter, leaving the mine literally without a dump. The specimens received by the United States National Museum are labeled as from the Kelly mine, which is one of the compact group now included in the California Rand properties.

There are a number of veins belonging to two systems that are rather complex in their relationships. The country rock consists of mica-albite and amphibole schists of pre-Cambrian age. Only two of the numerous silver veins outcropped, and one of these two is too low grade to be worked at a profit. The original discovery was made on the Shaft vein at the only point at which it came to

[1] Earl V. Shannon. The Minerals of Idaho. Bull. U. S. Nat. Mus. 131, pp. 148–150, 1926; Miargyrite and Tetrahedrite from the Flint District, Idaho. Amer. Min., vol. 13, No. 1, pp. 18–21, January, 1928.

[2] Arthur S. Eakle. Minerals of California. Calif. State Mining Bureau Bull. 91, p. 70, 1923, and Carlton D. Hulin. Geology and Ore Deposits of the Randsburg Quadrangle of California. Calif. State Mining Bureau Bull. 95, 1925.

[3] Hulin. Geology and Ore Deposits of the Randsburg Quadrangle of California, p. 108.

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the surface and the surface ore was very rich, assaying 300 ounces of silver and 3 ounces of gold to the ton. Adjacent to the veins the schists are commonly rather highly altered and frequently silicified and cut by veinlets of silica and pyrite. The walls of the veins are more or less indefinite and gradational.[4]

ORES

The richest specimens at hand consist of massive silver minerals, somewhat fractured and traversed by thin fillings of quartz. These contain a few cavities lined by crystals of miargyrite over which there may or may not be a discontinuous coating of clayey substance. The massive material consists principally of massive miargyrite. Hulin writes that miargyrite is the most abundant and important silver mineral of the region, but that stylotypite is only slightly less important. He says that the latter mineral is not apparent in the hand specimens, since it ordinarily occurs in minute irregular or rounded grains, commonly microscopic in size, which are usually entirely surrounded by miargyrite. The stylotypite is further almost invariably associated with chalcopyrite and occasionally with argentiferous bornite. Hulin defines stylotypite as a silver-bearing bournonite with the formula $3(Cu_2,Ag_2,Fe)S.Sb_2S_3$, which is the formula given for this mineral by Dana. It was identified by him in polished surfaces under reflected light and is described as brittle, metallic, dark gray in color, and with a black streak. Microchemical and blowpipe tests indicated the presence of silver, iron, antimony, and sulphur in the Randsburg mineral. On polished sections it is faintly gray and slightly lighter in color than the miargyrite.

Wherry and Foshag [5] give as the formula for stylotypite simply $3Cu_2S.Sb_2S_3$. Since the composition of this mineral is so incompletely known it was hoped that enough of the Randsburg material could be obtained for analysis. The coarse-grained massive high-grade ore was sawed and polished and etched on the polished surface with nitric acid. It was found to consist almost entirely of miargyrite which was unattacked by the nitric acid. There was present, however, a little interstitial material which etched bronzy and probably is the mineral identified as stylotypite by Hulin, but it was in such small amount and so intergrown with miargyrite as to render the separation of a portion for analysis impracticable.

The majority of the specimens of the lot consists of a breccia of fragments of dark gray fine-grained siliceous material the open interstices of which are lined with a layer of white quartz covered with a druse of minute transparent quartz crystals. It is resting upon the

[4] Hulin. Geology and Ore Deposits of the Randsburg Quadrangle of California, p. 112.

[5] Edgar T. Wherry and W. F. Foshag. A New Classification of the Sulphosalt Minerals. Journ. Wash. Acad. Sci., vol. 11, No. 1, pp. 1-8, January, 1921.

quartz crystals in these vugs that the best crystals of miargyrite are found, although other less perfect crystals line the vugs in massive miargyrite. Hulin notes that small amounts of arsenopyrite, pyrite pyrargyrite, proustite, chalcopyrite, argentiferous bornite, and stibnite also occur in the ore, but in the specimens at hand these minerals are not conspicuous and do not present any features worthy of special note. Green chromiferous mica is reported to occur rarely in altered wall rock in the outcrop of the Footwall vein.

The paragenesis of the minerals has been discussed in detail by Hulin. The stylotypite (?) is in part contemporaneous with quartz and is older than miargyrite, which sometimes replaces it. The order of genesis of the several minerals is given as:

A. Primary:
1. Silica (chalcedony and quartz).
2. Pyrite.
3. Arsenopyrite.
4. Stylotypite.
5. Chalcopyrite.
6. Argentiferous bornite.
7. Miargyrite.
8. Pyrargyrite.
9. Proustite.
10. Stibnite.
11. Calcite.

B. Secondary:
12. Secondary sulphides.
13. Cerargyrite.
14. Melanterite.

The following metallographic properties and reactions which are obtained on polished sections of the miargyrite are the characteristic ones for the species:

Color in section: Gray with red internal reflections in places.
Anisotropism: Strong.
Color in powder: Dark ruby red, distinctly darker than pyrargyrite.
1:1 HNO_3: Negative.
1:1 HCl: Fumes tarnish; in places negative.
20 per cent KCN: Slowly stains brown.
20 per cent $FeCl_3$: Negative.
40 per cent KOH: Stains iridescent.
5 per cent $HgCl_2$: Negative.

Since it was not desired to sacrifice the well-crystallized specimens by removing crystals enough to analyze, the analyzed material was taken from a coarse-grained massive specimen. (Cat. U.S.N.M. No. 95334.) By boring shallow pits in the centers of large and pure grains of miargyrite on polished surfaces 0.2 gram of pure sample was obtained. This was analyzed in the Museum laboratory with the following results:

Analysis of miargyrite from Randsburg, Calif.

Earl V. Shannon, analyst

	Found	Theory
Insoluble	0. 80	----------
Silver	36. 20	36. 90
Copper	. 02	----------
Iron	. 56	----------
Lead	. 95	----------
Antimony	42. 46	41. 20
Arsenic	Trace.	----------
Sulphur	19. 27	21. 90
	100. 26	100. 00

This analysis shows that the mineral is normal miargyrite, free from unusual constituents. It is a mineral of relatively low silver content as compared with the other silver minerals, with red streak which are commonly called ruby silver, and include proustite, pyrargyrite, and polybasite.

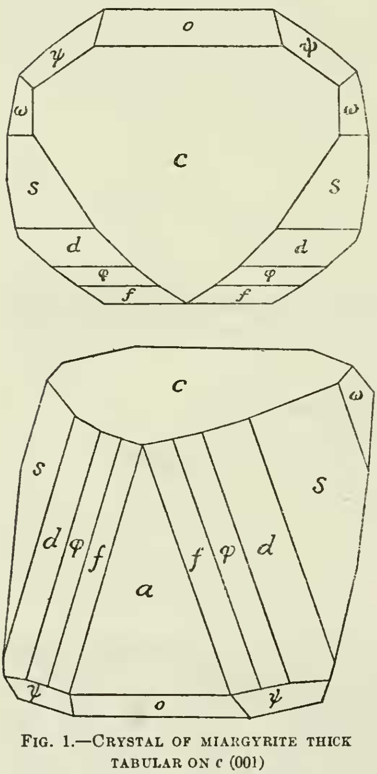

Fig. 1.—Crystal of miargyrite thick tabular on c (001)

The crystals of miargyrite occur either lining cavities in the massive mineral or implanted on the drusy quartz of the vugs in the breccia ore. They are very brilliant black in color but tend to tarnish and become iridescent in the air. None of those in the specimens at hand are large, the most of them being between 1 and 3 millimeters in diameter. They occur singly or in small clusters grown together in haphazard fashion. No recognizable twins were found.

This mineral is monoclinic in crystallization and crystals from all localities are characterized by a rather peculiar general habit, being thick tabular parallel to the base *c* (001) with a predominance of faces lying in the zone between the front pinacoid *a* (100) and the side dome (011). This is especially true of the Randsburg material. This habit makes the crystals very hard to orient. Although the basal pinacoid is usually present, this is inclined to the pole. The *a* (100) pinacoid is the only face developed in the prismatic zone and this is usually so striated as to give very poor signals. Even when the correct orientation is known, this habit makes very precise adjustment on the goniometer almost impossible. Moreover, most of the crystals appear to have been fractured through the center, and the halves, although firmly recemented, are displaced a degree or more with reference to each other.

The crystal illustrated in Figure 1 (crystal 1993) is from the specimen (Cat. No. 95334) of massive miargyrite which furnished the material for analysis. It is typical of those occurring in the vugs in massive ore, although the larger of these are deeply striated and grooved and, being crowded and grown flat against the walls of the cavity, are seldom completely developed. These are somewhat simpler in habit and show a less number of forms than those resting upon quartz druses. This crystal gave the following measurements:

Measurements of miargyrite crystal, Figure 1

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Fair	91 51	8 32	90 00	8 37
2	*a*	$\infty 0$	100	Good	90 00	90 00	90 00	90 00
3	*O*	-10	$\bar{1}01$	Fair	$\overline{90}$ 03	39 31	90 00	39 43
4	*A*	$+1$	111	do	22 03	71 43	21 18	72 15
5	*A*	$+1$	111	do	22 05	72 13	21 18	72 15
6	*S*	$+21$	211	Good	36 01	74 26	36 03	74 28
7	*S*	$+21$	211	P. blurred	35 28	73 53	36 03	74 28
8	*d*	$+31$	311	Good, dim	45 48	77 07	46 49	76 46
9	*f*	$+\frac{9}{2}1$	922	do	59 12	77 30	57 32	79 33
10	φ	$+41$	411	V. dim, end of zone	50 57	78 32	54 31	78 43
11	ψ	$-\frac{41}{33}$	413	Poor, dim	$\overline{49}$ 39	56 11	$\overline{50}$ 03	56 30
12	ψ	$-\frac{41}{33}$	413	do	$\overline{50}$ 48	56 11	50 03	56 30

All of the crystals are strongly striated in two zones. The most prominent set of striations is parallel to the intersections of the faces in the zone 100:011 and the faces of this zone are often rounded by oscillation between the various forms in this zone with many vicinal forms. The striation is more marked in the end of the zone toward the front pinacoid and diminishes toward the opposite end, the form (011) being usually brilliant. Another less prominent series of striae occurs in the zone (100):(001). These two sets of striations are both present on the *a* (100) face and this together with the triangular or inverted keystone shape of the face serves to identify it and to orient the crystal.

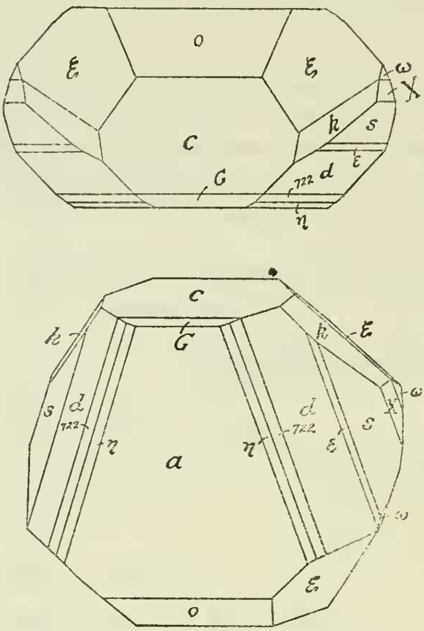

Fig. 2.—Crystal of miargyrite thick tabular on *a* (100)

The crystals implanted on the druses of quartz are somewhat more highly modified and vary from those which are thick tabular parallel to the front pinacoid to some which are tabular parallel to the base. Every gradation exists between these two types. The former is illustrated in Figure 2. This crystal gave the following measurements:

Measurements of miargyrite crystal, Figure 2

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Striated, blurred	90 01	8 00	90 00	8 37
2	*a*	∞0	100	Good	90 01	90 00	90 00	90 00
3	*a*	∞0	100	Excellent	89 41	90 01	90 00	90 00
4	*ω*	01	011	Good, minute	3 42	70 48	2 59	71 06
5	*o*	−10	$\bar{1}01$	Excellent	$\overline{89}$ 55	39 56	$\overline{90}$ 00	39 43

Measurements of miargyrite crystal, Figure 2—Continued

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
6	*X*	$+\frac{1}{2}1$	122	Excellent	21 32	71 53	19 48	72 05
7	*X*	$+\frac{1}{2}1$	122	do	21 18	72 06	19 48	72 05
8	*s*	+21	211	do	38 05	74 39	36 03	74 28
9	*s*	+21	211	Medium	36 00	74 04	36 03	74 28
10	new?	$+\frac{7}{2}1$	722	Excellent	49 05	76 43	50 59	77 48
11	*d*	+31	311	do	47 16	76 42	46 49	76 46
12	*d*	+31	311	do	47 45	76 43	46 49	76 46
13	ϵ	$+\frac{5}{2}1$	522	Good	42 17	75 32	41 53	75 39
14	η	+61	611	do	63 42	80 56	64 18	81 32
15	η	+61	611	Poor	65 23	82 00	64 18	81 32
16	*k*	$+\frac{11}{42}$	124	Very poor	16 29	56 32	15 19	56 27
17	*G*	$+\frac{1}{5}0$	105	V. p. stri	90 09	16 37	90 00	19 13
18	ξ	$\frac{21}{33}$	$\bar{2}13$	P. blurred	$\overline{30}$ 35	48 19	$\overline{27}$ 25	47 32
19	ξ	$\frac{21}{33}$	$\bar{2}13$	do	$\overline{30}$ 17	48 19	$\overline{27}$ 25	47 32

The only face which can not be reasonably referred to an established form is:

	° ′	° ′
No. 10. Measured	φ=49 05	ρ=76 43
722 calculated	50 59	77 48
Difference	Δ= 1 54	Δ= 1 05

These crystals vary gradually to the general type shown in Figure 3, in which the front pinacoid is reduced to a small face and the crystal is distinctly tabular parallel to the basal pinacoid *c* (001). The crystal of this type measured gave the angles:

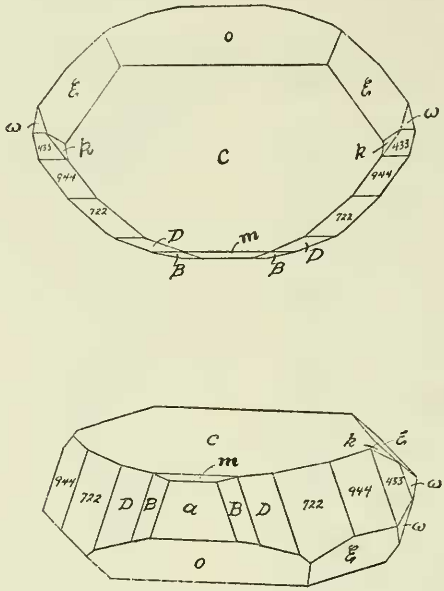

FIG. 3.—CRYSTAL OF MIARGYRITE TABULAR ON *c* (001)

Measurements of miargyrite crystal, Figure 3. (Lab. No. 1992)

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Stri., double	89 55	90 53	90 00	8 37
2	*a*	∞0	100	P. blurr	90 40	91 00	90 00	90 00
3	*m*	+10	101	V. v. p. line	91 23	48 36	90 00	48 37
4	*o*	−10	$\bar{1}01$	Med. blurred	$\overline{91}$ 00	38 09	$\overline{90}$ 00	39 43
5	*ω*	01	011	Good	2 48	70 30	2 59	71 06
6	*ω*	01	011	Med. blurred	2 49	70 20	2 59	71 06
7	*D*	+71	711	Narrow line	68 34	82 21	67 31	82 31
8	New?	$+\frac{7}{2}1$	722	P. end of zone	48 09	77 46	50 59	77 48
9	New?	$+\frac{7}{2}1$	722	Excellent	50 18	77 16	50 59	77 48

Measurements of miargyrite crystal, Figure 3—Continued

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
10	New?	$+\frac{7}{3}1$	733	Excellent	37 53	75 16	40 02	75 15
11	New?	$+\frac{7}{3}1$	733	Good	39 25	74 38	40 02	75 15
12	New?	$+\frac{4}{3}1$	433	Excellent	24 45	72 15	26 41	72 56
13	New?	$+\frac{4}{3}1$	433	do	24 59	72 15	26 41	72 56
14	*B*	+15. 1	15.1.1	Poor, rounded	78 18	86 00	78 57	86 14
15	*k*	$+\frac{11}{42}$	124	Good	19 30	56 34	15 19	56 27
16	*k*	$+\frac{11}{42}$	124	do	18 07	57 05	15 19	56 27
17	ξ	$-\frac{21}{33}$	$\bar{2}13$	Medium	$\overline{28}$ 44	47 34	$\overline{27}$ 25	47 32
18	ξ	$-\frac{21}{33}$	$\bar{2}13$	Poor, mult	$\overline{25}$ 16	47 34	$\overline{27}$ 25	47 32

Of the faces measured on this crystal three forms, represented by two faces each, are apparently new, although the quality of the faces is such that it can not be positively asserted the indices derived for these are correct. They are:

	° ′	° ′
No. 8	φ=48 09	ρ=77 46
No. 9	50 18	77 16
Average	49 14	77 31
722 calculated	50 59	77 48
Difference	Δ= 1 45	Δ= 0 17
No. 10	φ=37 53	ρ=75 16
No. 11	39 25	74 38
Average	38 39	74 57
733 calculated	40 02	75 15
Difference	Δ= 1 23	Δ= 0 18
No. 12	φ=24 45	ρ=72 15
No. 13	24 59	72 15
Average	24 52	72 15
433 calculated	26 41	72 56
Difference	Δ= 1 49	Δ= 0 41

The recognition of the crystal form of a "ruby silver" mineral may be of importance in identifying the mineral and consequently in estimating the probable silver content of the ore. The crystals of miargyrite (36.9 per cent silver) are readily distinguished from those of pyrargyrite (59.9 per cent silver), proustite (65.4 per cent silver), and polybasite (75.6 per cent silver). All of these have a red streak and pass under the name ruby silver.

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